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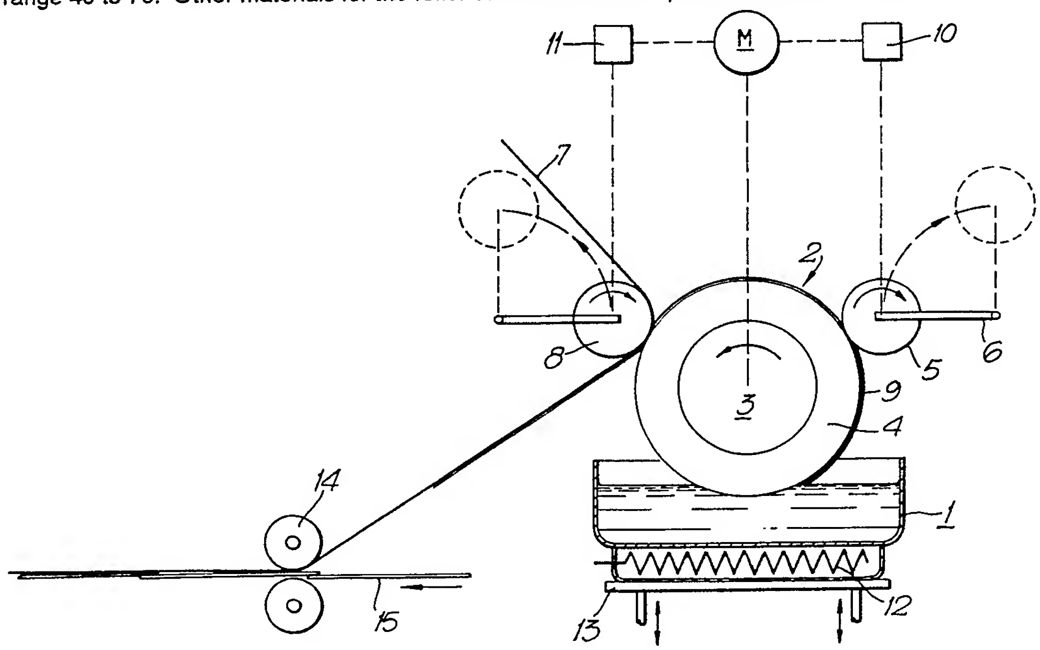
(54) **Coating apparatus**

(57) Coating apparatus, particularly for applying hot melt adhesive in a laminator, includes a transfer roller (2) having a poor affinity for the coating composition, so that a high proportion of the composition on the roller is transferred to a substrate (7). A suitable material for the roller surface (4) is silicone rubber. The transfer roller (2) picks up coating composition from a reservoir (1) provided with a heater (12). Double doctor rollers (5, 8) acting in series regulate the coating on the transfer roller (2). One doctor roller (8) supports the substrate (7) during application of the coating composition.

The material of the roller surface has a surface energy of 35 dynes per sq. cm. or less and a shore hardness in the range 40 to 70. Other materials for the roller surface include sulphone rubbers or PTFE.



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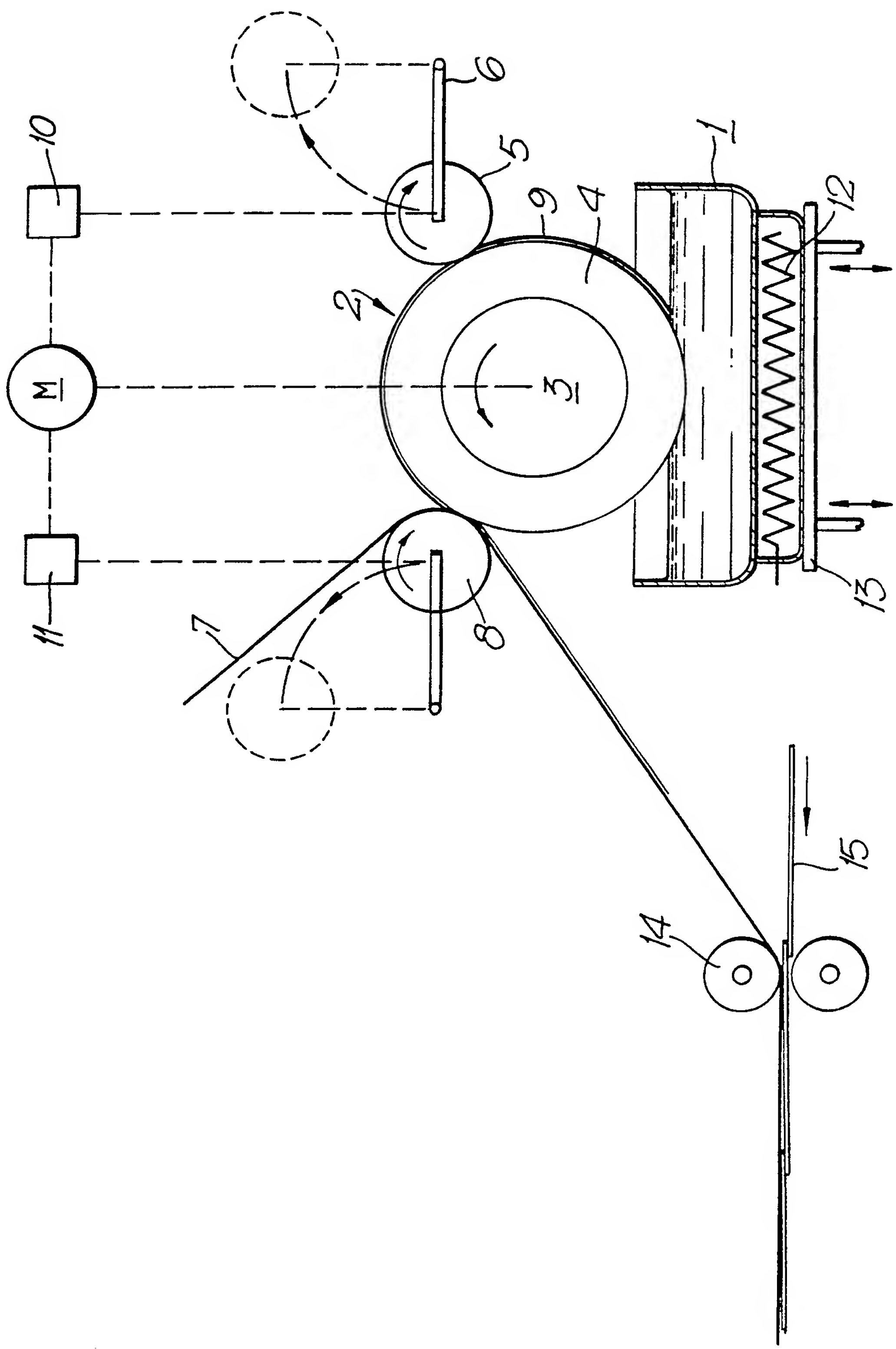

Coating Apparatus and Method

The present invention relates to a coating apparatus and method for applying a fluid coating composition to a substrate.

In the coating of sheet or web substrates with a fluid coating material, notably an adhesive, for example in the manufacture of laminated products such as plastic coated card or board or self-adhesive tapes, the fluid is commonly applied by means of a transfer roller which carries a coating of the material to be applied. The transfer roller is partially immersed in a trough of the fluid or fluid is fed onto the roller from above, so that the roller becomes coated with the fluid as it rotates. The fluid coating on the transfer roller is then transferred to the substrate.

In order that the amount of fluid coating on the transfer roller can be regulated and thereby control the amount of fluid applied to the substrate, a wiper mechanism, preferably in the form of a rotating doctor roller, commonly bears against the coated roller along its length to remove excess fluid from the surface of the roller. In order to accommodate irregularities in the surfaces of the rollers and to provide an area of contact rather than a simple line contact as would occur if two rigid cylindrical rollers were used, one of the rollers (usually the transfer roller) may be formed with a deformable surface layer.

However, the use of such rollers presents problems, particularly where the coating material is an adhesive or other relatively viscous or tacky fluid. Firstly, since the transfer roller must pick up adhesive from the reservoir during its rotation, its surface must have an affinity for the adhesive composition. As a result the coating of adhesive on the transfer roller is not wholly transferred to the substrate and a coating of adhesive builds up on the transfer roller. Since the coating effectively decreases the nip gap between the transfer roller and the backing surface supporting the substrate to which the adhesive is to be transferred, the coating will affect the amount of coating which can be transferred from the transfer roller to the substrate. Furthermore, it is difficult to clean the coating from the transfer roller at the end of a run. A further problem arises in that it is difficult to control accurately the amount of adhesive

transferred to the substrate at high substrate web speeds and erratic coating may occur.

Surprisingly, we have found that for many types of coating, particularly adhesives, the above problems may be reduced if a transfer roller with a surface having a poor affinity for the fluid coating composition is employed, despite the fact that it has hitherto been considered necessary for the surface of the roller to have a good affinity for the composition in order for adequate pick up of the composition to be achieved. Generally, the use of such a low affinity surface on the roller enables a high proportion of the coating composition carried on the transfer roller to be transferred to the substrate and this reduces build up of composition on the roller. It also permits the roller to be readily cleaned at the end of a run. Where high viscosity adhesives are applied with such a transfer roller, problems of excessive application of adhesive may arise, but we have devised a means for regulating the amount of adhesive applied by such a roller which reduces this potential problem.

The affinity of the roller surface is measured in terms of the surface energy of the material of the surface layer and it can readily be determined by simple tests whether or not a material has a surface energy within the desired range.

Accordingly, one aspect of the present invention provides apparatus for applying a fluid coating composition to a substrate, including a transfer conveyor arranged to receive a coating of the composition upon its surface and to transfer at least part of that coating to the substrate, the transfer conveyor being provided with a surface layer of a material having a surface energy of 35 dynes per square centimetre or less. Preferably the transfer conveyor is a rotatable transfer roller and is particularly suitable for use with fluid adhesive compositions. Without prejudice to the generality of the invention references are made hereinafter, for convenience, to coating apparatus incorporating a transfer roller for applying a coating of adhesive composition.

The surface energy of the surface material of the roller of the invention can be readily established at room temperature by applying fluids of different known surface energies to the material. If the fluid has a higher surface energy than the material being

tested, it will form discrete globules on the surface of the material. If it has a lower surface energy, it will wet the material and form a film of fluid spreading over the surface of the material. Test fluids having a range of known surface energies are commercially available and are suitable for use in testing materials for use in the present invention. The optimum material for present use will also have to meet the mechanical and other criteria required for successful operation in the given design of roller applicator and again this can be determined by simple trial and error tests.

It is preferred that the surface layer of the transfer roller have a Shore hardness of from 40 to 70, notably from 45 to 60, so that the transfer roller can be deformed at the nip contact with a further roller supporting the substrate or with a doctor roller as described below. Thus, suitable materials for present use include those based upon silicone rubbers, sulphone rubbers and compounded mixtures containing sufficient proportions of these with other natural or synthetic rubbers or polymers. The rubbers may contain other ingredients, such as fillers, required to achieve the desired Shore hardness and machinability for the manufacture of a surface layer. The rubber may contain other ingredients conventionally incorporated into rubber mixtures, e.g. anti-oxidants, plasticizers, vulcanising or cross-linking agents, etc. Many suitable materials are commercially available and may be used in their conventionally available forms.

The transfer roller may be made wholly from a suitable material. However, this may flex excessively as the roller is rotated and pressure from the doctor blade or roller is applied. It is therefore preferred to form the transfer roller as a steel or similar cylindrical core having an external sleeve of the rubber mounted thereon. It is preferred to machine the exterior of the sleeve when in situ to achieve the desired finish to the roller. In order to minimise excessive pick up and accumulation of adhesive on the roller surface, it is preferred that the transfer roller have a substantially non-porous surface and that it has irregularities of less than 1 micrometre from a perfect cylindrical surface. The surface of the transfer roller could be sprayed or otherwise coated with the poor affinity material; a PTFE coating could be applied in this way.

The low affinity roller of the invention can be used in a wide

range of types of adhesive roller coating apparatus to achieve the advantages offered by the surface layer. Thus, the transfer roller can be employed in coating machines in which the adhesive is fed onto the rotating transfer roller from above through a plurality of feed orifices, or in machines where the transfer roller is partially immersed in a reservoir of the adhesive composition and picks up a coating of the adhesive as it rotates.

The amount of adhesive or other coating composition transferred to the substrate will depend largely upon the thickness of the coating on the transfer roller at the point of contact between the transfer roller and the substrate. The thickness of this coating can be regulated in a number of ways, for example by a static wiper mechanism bearing against the coated roller along its length or by an air brush which blows excessive amounts of coating composition off the transfer roller. However, it is particularly preferred to use a rotating doctor roller having its axis parallel to the axis of rotation of the transfer roller. The amount of composition retained upon the transfer roller is regulated by the nip gap between the transfer and doctor rollers.

Whilst the use of a doctor roller to control the thickness of the coating provides satisfactory coating in many instances, problems arise when a very tacky adhesive or other fluid is used or when the fluid is applied to fast moving webs of the substrate. In such instances, irregular coatings of fluid on the substrate may occur and this limits the application of roller coating techniques. It is not possible to alter the rheology of the adhesive to overcome these problems since this will affect the composition of the adhesive and hence it properties.

It is believed that these problems are due to excessive shear working of the adhesive at the nip gap between the transfer and the doctor rollers due to the high nip pressures required to achieve sufficient reduction in the coating layer carried by the transfer roller.

Accordingly, another aspect of the present invention provides apparatus for applying a fluid coating composition to a substrate, including a transfer conveyor arranged to receive a coating of the composition upon its surface and to transfer at least part of that

coating to the substrate, wherein the amount of fluid coating carried by the transfer conveyor is regulated by two doctor rollers acting in series and rotatable about longitudinal axes substantially transverse to the direction of conveyance of said transfer conveyor.

Preferably, the transfer conveyor is a roller, and may be constructed in accordance with said one aspect of the invention. Preferably, the doctor rollers are mounted so that they can be moved out of cooperation with the transfer roller so as to permit access to the rollers for cleaning purposes. The use of two doctor rollers in series facilitates accurate control of the amount of composition retained on the transfer roller. The use of two doctor rollers is also of advantage when substrate web travel speeds in excess of 700 metres per hour are used.

The transfer roller carries the adhesive into contact with the substrate and transfers the adhesive it carries to the surface of the substrate. If desired, adhesive may be supplied to the transfer roller via one or more intermediate transfer rollers. The intermediate transfer rollers can be solid metal or can have a low affinity surface similar to the transfer roller.

Application of the adhesive occurs by transfer of the coating carried on the surface of the transfer roller as it is brought into contact with the substrate. This can be achieved by causing the substrate to follow a path through the coating apparatus on which it contacts the surface of the transfer roller. It is preferred that the substrate be supported so that there is a nip gap at which the transfer of adhesive from the transfer roller to the substrate takes place. Preferably, this nip gap is formed by the opposition of the transfer roller to a secondary roller. The secondary roller serves to support the substrate and can be adjustably mounted so that the pressure exerted at the nip gap can be varied. Whilst the secondary roller can be a freely idling roller which merely supports the substrate, it is preferred that it be driven by any suitable means so that it contra-rotates with respect to the transfer roller. Preferably, the co-operating surfaces of the rollers at the nip gap travel in the same direction, but with a speed difference, e.g. of about 0.15% or up to about 0.2%. This speed difference causes some shear working of the adhesive as it is applied to the substrate and

aids transfer of the adhesive from the transfer roller to the substrate.

In a particularly preferred embodiment of the invention, the secondary roller also serves as the second doctor roller in a series of two doctor rollers as described above for regulating the amount of adhesive carried by the transfer roller. In this arrangement the first doctor roller is preferably arranged to reduce the coating thickness to substantially the desired coating thickness, the second doctor roller serving to accurately control the evenness of the coating transferred to the substrate. Generally there should be no accumulation of fluid at the nip between the secondary and transfer rollers as this can cause over-coating, particularly at the edges of the substrate, and subsequent contamination of rollers downstream of the transfer roller. In such an embodiment, the doctor rollers can be fixedly mounted, but are preferably mounted so that they can be moved clear of contact with the transfer roller, e.g. by pivoting or linear movement at least initially in a radial direction relative to the transfer roller. This not only aids access to the surfaces of the rollers for cleaning, but also enables the substrate and optionally the first doctor roller to be lifted clear of the transfer roller. This enables coating of the substrate to be readily interrupted whilst continuing rotation of the transfer roller. This maintains a constantly renewed coating of adhesive on the transfer roller which reduces the risk of drying out of the adhesive on the roller which might occur if the transfer roller were halted. The doctor rollers are conveniently mounted with their longitudinal axes of rotation parallel to the axis of rotation of the transfer roller and at intervals of from 60 to 180° apart to bear against the surface of the coated transfer roller. The doctor rollers may be made from a suitable rigid material, such as a steel, and have a hard polished surface layer.

In a preferred arrangement the first doctor roller is provided with a surface having a poor affinity for the coating composition. The doctor roller may have a surface layer of a material substantially similar to that provided for the transfer roller in accordance with said one aspect of the invention. Thus the doctor roller may have a surface layer of a material having a surface energy of 35 dynes per square centimetre or less, eg. silicone rubber.

It has been previously mentioned that the secondary roller may have a peripheral speed which differs slightly (e.g. by up to 0.2%) from that of the transfer roller. Where there are two doctor rollers (the second of which is the secondary roller) the first doctor roller may similarly be driven at a slightly different peripheral speed. Preferably, however, the first doctor roller is maintained almost stationary, being rotated just sufficiently to present a gradually changing contact surface. This has the advantage of reducing or eliminating the tendency for the doctor roller to pick up coating composition on its own surface (as opposed to removing or regulating the coating on the transfer roller). The arrangement has the further advantage that it allows use of a substantial nip pressure with what is almost a stationary doctor blade, thereby ensuring effective regulation of the coating thickness without the resultant high wear rate which would accompany use of such pressures with a static doctor blade. Moreover, it would be difficult to manufacture and/or maintain adjustment of a static blade capable of withstanding these pressures and having sufficiently accurate construction to allow an even, thin coating to pass. Preferably the doctor roller is driven by reduction gearing from the drive for the transfer roller: a suitable speed ratio is 1000:1 or even higher.

The amount of fluid transferred to the substrate will depend largely upon the thickness of the coating on the transfer roller at the coating station, which is regulated by the nip gap between the transfer roller and each of the doctor rollers. It is preferred that the first doctor roller reduce the coating to approximately the desired level and that the second doctor roller serve accurately to control the thickness of the coating for the coating station. Particularly when the second doctor roller is also the secondary roller, it is very desirable that the first doctor roller should pass only that quantity of fluid corresponding to the desired coating thickness, so that there is no accumulation of fluid at the nip between the second doctor roller and the transfer roller.

In an ideal situation, the contact between the doctor rollers and the adhesive coated transfer roller would be a line contact with negligible tangential dimension so as to reduce shear working of the adhesive at the nip gap to a minimum. However, this requires

excessive accuracy in fabrication of the rollers and the doctor rollers are set so that some flattening of the surface of the transfer roller occurs at the nip gap to accommodate variations in the roller surfaces. The optimum nip gap for achieving the desired loading of adhesive on the transfer roller and the transfer of the desired amount to the substrate can readily be determined by simple trial and error tests. Typically the nip gap will extend tangentially over 1 cm or less of the surface of the transfer roller.

Where the coating composition comprises a hot melt adhesive, it is necessary to maintain the rollers of the coating apparatus at above the melting temperature of the adhesive. Conventionally this is done by a variety of methods, for example by passing a heated oil or other heat exchange medium through the core of the roller via suitable rotary seals, by infra-red heating of the exterior of the rollers or by enclosing the whole assembly within a thermally insulated enclosure and passing hot air through the enclosure or otherwise heating the apparatus within the enclosure.

Such methods are cumbersome, complex and expensive and the use of rotating seals gives rise to problems. Where hot air is used to heat the rollers, problems arise due to accelerated drying of the adhesive film on the roller surface and external radiant heating methods can cause localised over-heating of the roller and the adhesive film. The application of hot melt adhesives using roller applicators has therefore presented problems.

We have found that the heat required to maintain the adhesive molten on the rollers of the applicator apparatus can be provided substantially completely by heat derived from the molten material in the reservoir. Heat transfer between the various rollers of a compact coating apparatus where the adhesive is applied directly from the transfer roller to the substrate is sufficient to maintain the adhesive in a molten condition until it is applied to the substrate without the need to apply further heat to the apparatus. This overcomes many of the problems associated with other methods for heating the rollers and enables a compact, simple and economic apparatus to be constructed.

Accordingly, a further aspect of the present invention provides apparatus for applying a fluid coating composition, notably a molten

adhesive composition, to a substrate, comprising a reservoir for the composition having heating means for heating the composition in said resevoir, and a transfer conveyor arranged to be at least partially immersed in the composition in said reservoir and to receive a coating of the composition upon its surface and to transfer at least part of that coating to said substrate, wherein the major part of the heat required to maintain said composition at an elevated temperature upon said transfer conveyor and until it is applied to the substrate is provided by said heating means for the composition in said reservoir. Preferably the transfer conveyor is a roller. When used for applying a molten adhesive or other molten composition the heating means is arranged so that it supplies the major part of the heat to maintain the composition at such elevated temperature that it remains in a molten condition.

Preferably, the apparatus comprises an elongated trough for the reservoir having one or more electrical heating elements to act on the contents of the reservoir, for example by heating a wall, notably the basal wall of the reservoir. Preferably, the reservoir is in the form of an open-topped trough which is mounted so that it can be raised or lowered to carry the transfer roller clear of the contents of the trough at the end of an operation. The contents can then be allowed to cool and solidify in the trough and be re-heated at the start of the next operation out of contact with the transfer roller, thus reducing the risk of thermal or mechanical damage to the transfer roller.

Reference herein to size of the nip gap between rollers should not be taken to imply that there is any natural clearance between the rollers. On the contrary, in practice in operation of coating apparatus of the present type it is necessary to apply significant pressure between operating rollers in order to achieve effective reduction of the coating thickness to an even, thin layer. Generally, it is desired to produce a very thin, even layer: as well as having the obvious desirability of economy with the coating composition a thin layer of adhesive produces a more effective bond, e.g. for laminating, than a thick layer. Typically the apparatus of the invention is capable of coating at a rate of 10-30 grams/square metre or less.

The separate aspects of the invention may be embodied in apparatus in any combination: in particular, the same apparatus may incorporate each of said aspects of the invention.

The invention also extends to a method of applying a fluid coating composition to a substrate by means of apparatus according to any aspect of the invention.

The invention will be further described, by way of example only, with reference to the accompanying drawing which is a diagrammatic vertical section through a coating apparatus.

In the apparatus shown a fluid adhesive composition is held in a generally rectangular reservoir or trough 1. The trough 1 may have a flat bottom as shown or can have a rounded bottom to accommodate the shape of a transfer roller 2 which is mounted with its longitudinal axis of rotation generally parallel to the axis of the trough 1 and with from 5 to 30%, notably 15 to 25%, of the circumference of the roller immersed in the adhesive in the trough. For example, from 1 to 5 cm of the diameter of the transfer roller 2 may be immersed. The transfer roller 2 is driven by a suitable motor M and adhesive is fed to the trough 1 to maintain the desired level in the trough. The adhesive can be a water or solvent based composition or a hot melt composition.

The transfer roller 2 comprises a solid steel or stainless steel core 3 having a machined sleeve 4 of a silicone rubber having a Shore hardness of about 50 mounted on the core. Typically, the sleeve 4 has a radial thickness of from 2 to 10 mm. The sleeve 4 is made from a silicone rubber which has a surface energy of approximately 30 dynes per square cm at 20°C.

As the transfer roller 2 rotates it picks up a coating 9 of adhesive. The thickness of this coating 9 is regulated by the nip gap between the roller 2 and a doctor roller 5 mounted with its axis of rotation parallel to that of the transfer roller 2 upon pivot arms 6 which allow the roller 5 to be moved out of contact with roller 2, as shown dotted in the drawing. Roller 5 has a sleeve of silicone rubber, similar to the sleeve 4, and a steel core; alternatively the roller 5 could be made from steel and have a polished hard surface.

A web of sheet polypropylene 7 is fed from a storage reel (not shown) over a roller 8 so that it passes through the nip gap between

rollers 2 and 8. Roller 8 is made from steel and has a polished hard surface and is mounted on pivoting arms 9 so that it can be moved out of contact with transfer roller 2. Roller 8 serves to support the web 7 so that the adhesive is transferred to the web from roller 2 at the nip gap. Roller 8 also acts as a second doctor roller to control the amount of adhesive transferred from roller 2 to the web 7 by virtue of the size (or pressure) of the nip gap between rollers 2 and 8.

Whilst this is not necessary, rollers 5 and 8 are preferably mounted symmetrically about the axis of rotation of the transfer roller 2. Rollers 5 and 8 contra-rotate relative to roller 2, with a peripheral linear speed of about 0.15% greater than that of roller 2. This speed difference may be achieved by accurate control of the roller diameters. As shown in the drawing, the transfer roller 2 is driven by a motor M, and the rollers 5 and 8 are driven at speeds related to that of the roller 2 by transmissions from the motor respectively including gearboxes 10 and 11. The gearbox 10 may be arranged to rotate the roller 5 very slowly, e.g. at a ratio of 1 : 1000, relative to the roller 2, so that it acts in effect as a static doctor blade with a gradually changing operative surface.

The apparatus was used successfully to apply a number of adhesive compositions to a web 7 of polypropylene sheet passing through the nip between rollers 2 and 8 at speeds of up to 700 metres per hour. The coating operation was interrupted a number of times by swinging rollers 5 and 8 radially outward from roller 2. The coating of fluid on roller 2 was maintained in the moist condition, the roller 2 continuing to rotate, and re-application of adhesive to the web 7 could be commenced merely by swinging the rollers 5 and 8 back into contact with roller 2. The coated sheet was then applied to a card substrate to form a laminated structure or could be cut longitudinally to provide pressure sensitive adhesive tape.

The presence of the second doctor roller 8 enabled the amount of adhesive applied to the web 7 to be accurately controlled even with highly tacky pressure sensitive adhesives without excessive shear working and degradation of the adhesive occurring.

The coating apparatus may be used with a coating composition consisting of a molten material. The molten material can be any thermoplastic composition which it is desired to apply to the

substrate, for example a paint or ink which is to be applied as a continuous coating to the substrate. Alternatively a hot melt adhesive, such as a vinylic polymer, for example an ethylene vinyl acetate polymer, in a fusible wax or resin carrier, may be applied to a sheet substrate such as a sheet or web 7 of a polyalkylene or polyvinylic polymer, which is then applied as a protective layer to a sheet of paper, card or board to form a laminated structure. For convenience, the invention will be further described in terms of the manufacture of such a laminate using hot melt adhesive, it being understood that the coating apparatus is usable for purposes other than in a laminating apparatus, and that adhesives other than hot melt adhesives are usable with the coating or laminating apparatus.

The trough 1 is provided with heating means to melt the adhesive composition to be applied. The heating means can be of any suitable type, but is preferably provided by one or more electrical heating elements 12 either mounted internally of the trough 1 to heat the adhesive composition directly and/or mounted externally to act upon one or more walls of the trough to heat the adhesive composition indirectly.

As indicated above, the heating element 12 serves not only to maintain the contents of the trough 1 molten, but also to provide the energy to maintain the rollers 2, 5 carrying the molten adhesive onto the surface of the substrate at the desired temperature by thermal transfer between the trough and the rollers. The heater 12 therefore is of greater heating output than hitherto. The optimum heat output for the heater can readily be determined for any given case by simple tests. If desired, the heat output of the heater 12 can be made adjustable to accommodate variations in the materials being processed in the apparatus.

It is preferred that the trough 1 be capable of being moved, e.g. raised or lowered, so that it can be moved away from the transfer roller at the end of an operation. Accordingly the trough 1 is carried by a vertically-movable table 13. This allows the contents of the trough 1 to cool and set without also locking up the transfer roller 2, with the attendant risk of mechanical damage to the roller during attempts to start rotation of the roller before the adhesive in the trough is fully molten. Since the solid adhesive is often a poor

thermal conductor, thermal damage to the transfer roller 2 could also occur during initial re-melting of the adhesive if it were left in the trough 1 between operations. We have also found that the heat emitted from the trough 1 and its contents during re-melting of the adhesive is often sufficient to preheat the transfer roller 2 to the desired operating temperature so that little or no re-solidification of the adhesive occurs when the transfer roller is immersed in the trough, thus aiding fast start up of the apparatus.

The adhesive can be fed as solid particles or blocks to the trough 1 for melting within the trough. Alternatively, the solid adhesive can be melted in a pre-heating stage and the molten adhesive fed as and when needed to the trough 1.

The substrate web 7 to which the adhesive coating on roller 2 is applied can be selected from a wide range of materials, for example sheet plastic such as a polyalkylene or a polyvinylic polymer which can be pigmented or otherwise treated as is known in the art of laminate formation. The web 7 is preferably fed from a supply reel directly to the nip between rollers 2 and 8. However, the substrate may be given a pretreatment, such as corona discharge treatment of its surface to improve adhesion of the adhesive thereto, if desired, using known techniques. The coated web 7 issuing from rollers 2 and 8 can be applied to a further substrate, for example card or board sheet, which may be partly overlapped, to adhere the coated substrate thereto to form a laminated structure in known manner. Thus, the coated substrate can pass between the nip of a pair of rollers 14 into which is fed a series of sheets 15 of printed card, and the composite structure then passed under cooling air blasts or the like to solidify the adhesive between the layers of the structure.

As stated above, the necessary heat to retain the adhesive in its molten state as it travels from trough 1 towards roller 8 is provided from the heat supplied to the trough and is carried through the roller system by heat transfer between the rollers. We have found that for most purposes the heat transferred is sufficient to maintain the surfaces of the rollers 2, 5, 8 at the desired temperature. However, where this is not the case, supplementary heat can be applied to the surface of any or all of the rollers 2, 5, 8 by infra red or similar heaters. Since the majority of the heat has been supplied to

the rollers 2, 5, 8 by heat transfer from the trough 1, such supplementary heating supplies only a minor amount of the total heat and problems with localised over- or under-heating of the roller surfaces are minimised.

Claims

1. Apparatus for applying a fluid coating composition to a substrate, including a transfer conveyor arranged to receive a coating of the composition upon its surface and to transfer at least part of that coating to the substrate, the transfer conveyor being provided with a surface layer of a material having a surface energy of 35 dynes per square centimetre or less.

2. Apparatus as claimed in claim 1, wherein the transfer conveyor has a surface region having a Shore hardness in the range 40 to 70.

3. Apparatus as claimed in claim 1 or claim 2, wherein the transfer conveyor has a surface layer comprising a material selected from a group of materials including silicone rubbers, sulphone rubbers, and compounded mixtures of either of said rubbers with other natural or synthetic rubbers or polymers.

4. Apparatus as claimed in any preceding claim, wherein the surface of said transfer conveyor is substantially non-porous.

5. Apparatus as claimed in any preceding claim, wherein said transfer conveyor comprises a rotatable transfer roller.

6. Apparatus as claimed in claim 5, wherein said transfer roller comprises a relatively rigid core and a relatively resilient sleeve comprising said surface layer.

7. Apparatus as claimed claim 5 or claim 6, including a secondary roller supporting the substrate and rotatably mounted with its axis of rotation substantially parallel with the axis of rotation of the transfer roller, the transfer roller and secondary roller defining a nip between them and at which the substrate receives a coating of the composition.

8. Apparatus as claimed in claim 7, wherein the transfer roller and secondary roller are mounted so that the pressure at said nip can be varied.

9. Apparatus as claimed in claim 7 or claim 8, including means for rotating said transfer and secondary rollers at different peripheral speeds.

10. Apparatus as claimed in claim 9, wherein said respective rotating means are arranged so that said speeds differ by up to 0.2%.

11. Apparatus as claimed in any of claims 5 to 10, including a doctor roller for regulating the coating on said transfer roller upstream of said secondary roller.

12. Apparatus as claimed in claim 11, including means for rotating said doctor roller at a peripheral speed which differs from that of said transfer roller.

13. Apparatus as claimed in claim 12, wherein said means for rotating said doctor roller is arranged to rotate said doctor roller at a speed which differs from that of said transfer roller by up to 0.2%.

14. Apparatus as claimed in claim 12, wherein said means for rotating said doctor roller is arranged to rotate said roller at a very slow speed, so that its surface which regulates the coating on said transfer roller slowly changes.

15. Apparatus as claimed in claim 14, wherein said means for rotating said doctor roller includes a transmission connected with means for rotating said transfer roller, said transmission including a ratio device having a ratio of 1000 or more to 1.

16. Apparatus as claimed in any preceding claim, including a reservoir for the coating composition, the transfer conveyor being arranged to be at least partially immersed in the reservoir to receive a coating of the composition therefrom, and heating means for the composition in said reservoir, the heating means being such that at least the major part of the heat required to maintain the composition at a desired elevated temperature on said transfer conveyor and until it is applied to the substrate is provided by said heating means for the compsition in said reservoir.

17. Apparatus as claimed in any preceding claim, wherein the transfer conveyor is normally partly immersed in a fluid coating composition contained in a reservoir, including means for separating the transfer conveyor and the composition in the reservoir, so that the transfer conveyor becomes no longer immersed.

18. Apparatus as claimed in claim 7 or any preceding claim dependent on claim 7, including means for separating said transfer and secondary rollers.

19. Apparatus as claimed in claim 11 or any preceding claim dependent on claim 11, including means for separating said transfer roller and said doctor roller.

20. Apparatus for applying a fluid coating composition to a substrate, including a transfer conveyor arranged to receive a coating of the composition upon its surface and to transfer at least part of that coating to the substrate, wherein the amount of fluid coating carried by the transfer conveyor is regulated by two doctor rollers acting in series and rotatable about longitudinal axes substantially transverse to the direction of conveyance of said transfer conveyor.

21. Apparatus as claimed in claim 20, wherein the doctor rollers are mounted for movement towards and away from the transfer conveyor.

22. Apparatus as claimed in claim 20 or claim 21, wherein the downstream doctor roller, with respect to the direction of conveyance

of said transfer conveyor, serves to support the substrate while the coating is being applied to it from the transfer roller.

23. Apparatus as claimed in any of claims 20-22, including drive means for the transfer conveyor and at least one of the doctor rollers, said drive means including means for moving said transfer conveyor and said one doctor roller at different speeds.

24. Apparatus as claimed in claim 23, wherein said drive means for said one doctor roller is arranged to rotate said one doctor roller at a slow speed relative to the speed of rotation of said transfer roller.

25. Apparatus as claimed in any of claims 20 to 24, wherein at least one of said doctor rollers has a surface layer having a surface energy of 35 dynes per square centimetre or less.

26. Apparatus as claimed in claim 25, wherein said surface layer has a Shore hardness in the range 40 to 70.

27. Apparatus for applying a fluid coating composition, comprising a reservoir for the composition having heating means for heating the composition in said reservoir, and a transfer conveyor arranged to be at least partially imersed in the composition in said reservoir and to receive a coating of the composition upon its surface and to transfer at least part of that coating to said substrate, wherein the major part of the heat required to maintain said composition at an elevated temperature upon said transfer conveyor and until it is applied to the substrate is provided by said heating means for the composition in said reservoir.

28. Apparatus as claimed in claim 27, including means for separating the transfer conveyor and the composition in the reservoir, so that the transfer conveyor becomes no longer immersed in the composition.

29. Apparatus as claimed in claim 28, wherein said separating means includes means for moving said reservoir relative to said transfer conveyor.

30. Apparatus as claimed in any of claims 1-19, incorporating apparatus as claimed in any of claims 20-29.

31. Apparatus as claimed in any of claims 20-26, incorporating apparatus as claimed in any of claims 27-29.

32. Laminating apparatus, incorporating apparatus as claimed in any preceding claim.

33. A method of applying a fluid coating composition to a substrate, in which the composition is applied by means of a transfer conveyor having a surface layer having a surface energy of less than 35 dynes per square centimetre and a Shore hardness in the range 40-70.

34. A method of applying a fluid coating composition to a substrate, in which the composition is required to be at an elevated temperature, wherein the major part of the heat required to maintain the composition at said temperature until it is applied to the substrate is provided by heating a source of the composition from which the composition is withdrawn for application to the substrate.

35. Apparatus substantially as herein described with particular reference to the accompanying drawing.

36. A method of applying a fluid coating composition, substantially as herein described with particular reference to the accompanying drawing.

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ABSTRACT:

CHG DATE=19990617 STATUS=O> Coating apparatus, particularly for applying hot melt adhesive in a laminator, includes a transfer roller (2) having a poor affinity for the coating composition, so that a high proportion of the composition on the roller is transferred to a substrate (7). A suitable material for the roller surface (4) is silicone rubber. The transfer roller (2) picks up coating composition from a reservoir (1) provided with a heater (12). Double doctor rollers (5, 8) acting in series regulate the coating on the transfer roller (2). One doctor roller (8) supports the substrate (7) during application of the coating composition. The material of the roller surface has a surface energy of 35 dynes

per sq. cm. or less and a shore hardness in the range 40 to 70. Other materials for the roller surface include sulphone rubbers or PTFE.